

Description

CENTRIFUGAL PUMP

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of United States Provisional Application No. 60/430,057 filed 2 December 2002, the disclosure of which is expressly incorporated herein by reference in its entirety.

BACKGROUND OF INVENTION

TECHNICAL FIELD

[0002] The present invention relates to a centrifugal pump with an impeller which is rotatable in a direction of rotation in a pump housing and includes an essentially circular-disk-shaped carrier with a number of blades that are arranged at an angle out from the disk plane and extend in an essentially curved shape between an inner radial edge and an outer radial edge.

BACKGROUND

[0003] Centrifugal pumps have many areas of application, for ex-

ample for pumping or pressurizing various media in a stationary manner, or for pumping coolant between heat sources and cooling devices in cooling systems in engine-driven land vehicles and other craft. Within the area of application of heavy-duty vehicles, for example trucks, manufacturers can usually offer customers a model range which comprises (includes, but is not limited to) a number of different engine sizes, and where each engine type comes in various power classes which can be adapted based on requirements associated with vehicle equipment variations where the varying factors have a direct effect on the flow conditions of the cooling system. Examples of such equipment that is adapted to such requirements include engine coolers, gearbox oil coolers, charge-air coolers, coolers for EGR gas and coolers for retarders.

- [0004] Centrifugal pumps are normally designed so that they are optimized for a given speed and for a given flow. If the pump operates outside its specifications, cavitation may occur. Alternatively, unnecessary power losses may occur. An assortment of different water pumps is therefore required in order to cover the requirements. Moreover, it is possible to adapt the ratio between the driving shaft and the pump; for example, by gear ratio variations in a gear

transmission. It is desirable for it to be possible for manufacturers of heavy-duty vehicles to use the same standard component, for example a water pump, for more variants (differently configured vehicles) than is currently possible. Moreover, it would be easier to modify a used vehicle, for example for adaptation to new environmental requirements or use conditions if such adaptation did not involve exchange of the coolant pump.

SUMMARY OF INVENTION

- [0005] One object of the present invention is therefore to produce a centrifugal pump that is able withstand operation within a wide speed range, a wide flow range and with maintained high efficiency in all such operating conditions.
- [0006] To this end, a centrifugal pump configured according to the present invention is characterized by the fact that at least one of the blades of the pump's impeller extends with a first curved portion which is concave in the direction of rotation of the impeller, and a second curved portion which is convex with respect to that same direction of rotation. The first curved portion extends from the inner radial edge to the second curved portion and the second curved portion extends from the first curved portion in

the direction of the outer radial edge. This design of the blade(s) of the impeller results in high efficiency performance within both a wide range of speeds and a wide flow range.

BRIEF DESCRIPTION OF DRAWINGS

- [0007] The invention will be described in greater detail below with reference to illustrative embodiments, of which examples are shown in the accompanying drawings, in which:
- [0008] FIG. 1 is a plan view of an impeller used in a centrifugal pump configured according to the teachings of the present invention;
- [0009] FIG. 2 is a cross-sectional view taken along the line 2-2 of Fig. 1; and
- [0010] FIG. 3 is an illustrative graph demonstrating the relationship between efficiency and flow at different speeds for a pump installation with a centrifugal pump configured according to the present invention.

DETAILED DESCRIPTION

- [0011] The impeller 10 shown in Fig. 1 comprises a circular disk-shaped carrier 11 with a central hub 12 and blades 13 arranged peripherally outside the hub. The blades 13

project at an angle from the disk plane and extend in an essentially curved shape between a position proximate an inner radial edge to a position proximate an outer radial edge of the carrier 11. In the context of the present disclosure, the terminology of "essentially" and "substantially" are utilized to define qualities and characteristics that are sufficiently in compliance with the so-described characterization to produce similar performance. The impeller 10 is intended to be used in a pump housing (not shown) and mounted so that the hub 12 is positioned on a short driving shaft. In this regard, the inlet of the pump housing is directed essentially at right angles to the disk plane, straight toward the impeller hub 12. The outlet of the pump housing is directed essentially tangentially out from the outer radial edge of the impeller, parallel to the disk plane.

- [0012] The impeller 10 is arranged to rotate in the direction indicated by the arrow 14 in Fig. 1 during pumping operation. The blades 13 extend with a first curved portion 15 from a position adjacent the impeller hub 12 and is concave in a direction facing the direction of rotation. A second curved portion 16 that extends generally radially outwardly from the first curved portion 15 is convex in the

direction facing the direction of rotation. The length of the first curved portion is approximately a third of the length of the second curved portion. Each blade extends from an inner end 17 to the outer end 18. The inner ends 17 of the plurality of blades 13 are arranged concentrically (defined by an inner radius) on the carrier 11 and inside the inlet of the pump housing, which is illustrated by the dashed circle 19 in Fig. 1. The peripherally outermost tip part of each blade can be of tapering design. By virtue of the design of the blades 13 according to the teachings of the invention, more effective feeding of liquid into the concave part of the blades takes place, which part is shaped so as to reduce the risk of cavitation.

- [0013] As can be appreciated from Fig. 2, the blades in the illustrative embodiment that is shown are inclined with an angle 20 of roughly 80 degrees relative to the disk plane of the carrier 11 on that side of the blade 13 that faces in the direction of rotation. The angle can be made smaller or larger than that shown. Alternatively, the blades can be of curved design in the direction of rotation. A number of variants are therefore possible; for example, the average inclination angle of the blades can be varied between approximately 45 degrees and approximately 87 degrees.

- [0014] Furthermore, the edge of the blades 13 opposite the carrier disk 11 has an oblique bevel 21, with the tip of the bevel, and in turn the blade 13, directed toward the direction of rotation. In the illustrative embodiment shown, the oblique bevel is at roughly 10 degrees in relation to the disk plane of the carrier, but this angle 22 can be varied between approximately 3 degrees and approximately 30 degrees. It has been found that this bevel reduces the risk of cavitation, while at the same time increasing pump efficiency.
- [0015] In the illustrative embodiment described above, the impeller 10 is arranged to rotate in a pump housing with the blades interacting with a pump housing wall that is parallel and close to the disk plane of the carrier. In an alternative exemplary embodiment, an impeller configured according to the teachings of the present invention can comprise a disk that is oriented parallel to the disk plane of the carrier, connected to the blades and provided with a central inflow opening. In the case of such an impeller that is "closed" in this way, the blades do not have to be inclined and beveled as described above.
- [0016] The graph shown in Fig. 3 illustrates the relationship between pump efficiency and flow at four different pump

revolutional speeds, from approximately 1500 rpm to approximately 3500 rpm. As can be seen from the graph, an efficiency of roughly 65% can be maintained, with a flow Q varying between six and fourteen liters per second. This same pump that is configured according to the teachings of the present invention can therefore be used in many different applications with varying flow/pressure drop. Furthermore, the pump can operate with high efficiency over a wide speed range, the gear ratio of the pump therefore does not have to be specially adapted to the different applications.

- [0017] The invention is not to be considered as being limited to the illustrative embodiments described above, but a number of further variants and modifications are conceivable within the scope of the patent claims. For example, all of the blades 13 of the impeller 10 do not have to have exactly the same shape, but it is contemplated, for example, that every other blade can be made shorter than shown, without the effect of the invention being lost completely.